MULTIMEDIA UNIVERSITY

STUDENT ID NO

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# MULTIMEDIA UNIVERSITY

# FINAL EXAMINATION

**TRIMESTER 2, 2015/2016**

## BTS3014 – TIME SERIES ANALYSIS & FORECASTING

( All sections / Groups )

12 MARCH 2016
2.30 p.m. – 4.30 p.m.
( 2 Hours )

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**INSTRUCTIONS TO STUDENTS**

1. This question paper consists of **FOUR (4)** questions in **SIX (6)** printed pages.
2. Answer **ALL** questions in the answer booklet provided.
3. Show all calculation workings in the answer booklet.
4. Marks are shown at the end of each question.

## Question 1

(a) Explain the difference between simple exponential smoothing and linear exponential smoothing. (6 marks)

(b) Suppose the following are the production cost data for KFB Company.

| Year | Cost ($ million) |
|---|---|
| 2009 | 0.81 |
| 2010 | 0.95 |
| 2011 | 1.12 |
| 2012 | 1.33 |
| 2013 | 1.69 |
| 2014 | 1.83 |

Based on the data above, forecast the KFB Company's production cost from 2012 to 2014 using the following forecasting methods (assume $\alpha = 0.51, \beta = 0.22$):

(i) Simple exponential smoothing. (3 marks)

(ii) Linear exponential smoothing. (6 marks)

(c) Compute MAE and RMSE for each forecasting method. (6 marks)

(d) Based on part (b), suggest which forecasting method that performs better. Explain. (4 marks)

**[Total marks: 25 marks]**

## Question 2

(a) The following tables are the unit root test and correlogram outputs computed using EViews for Malaysia's annual inflation rate from 1991 to 2004:

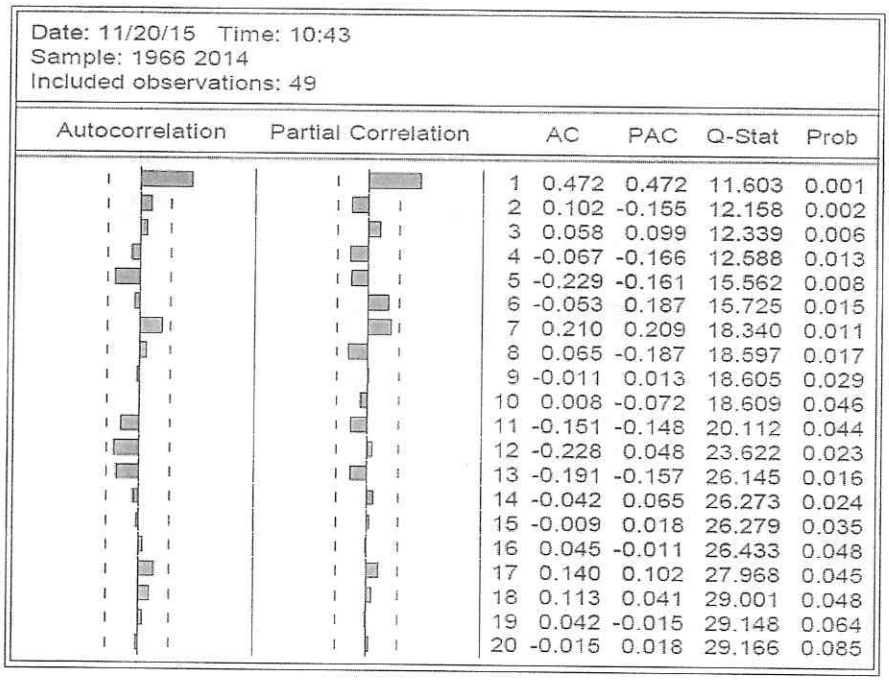
Null Hypothesis: INFLATION has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=10)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -4.306804 | 0.0068 |
| Test critical values: | 1% level | -4.161144 | |
| | 5% level | -3.506374 | |
| | 10% level | -3.183002 | |

*MacKinnon (1996) one-sided p-values.

Continued...

Correlogram of INFLATION



Date: 11/20/15 Time: 10:43
Sample: 1966 2014
Included observations: 49

| Autocorrelation | Partial Correlation | | AC | PAC | Q-Stat | Prob |
|---|---|---|---|---|---|---|
| | | 1 | 0.472 | 0.472 | 11.603 | 0.001 |
| | | 2 | 0.102 | -0.155 | 12.158 | 0.002 |
| | | 3 | 0.058 | 0.099 | 12.339 | 0.006 |
| | | 4 | -0.067 | -0.166 | 12.588 | 0.013 |
| | | 5 | -0.229 | -0.161 | 15.562 | 0.008 |
| | | 6 | -0.053 | 0.187 | 15.725 | 0.015 |
| | | 7 | 0.210 | 0.209 | 18.340 | 0.011 |
| | | 8 | 0.065 | -0.187 | 18.597 | 0.017 |
| | | 9 | -0.011 | 0.013 | 18.605 | 0.029 |
| | | 10 | 0.008 | -0.072 | 18.609 | 0.046 |
| | | 11 | -0.151 | -0.148 | 20.112 | 0.044 |
| | | 12 | -0.228 | 0.048 | 23.622 | 0.023 |
| | | 13 | -0.191 | -0.157 | 26.145 | 0.016 |
| | | 14 | -0.042 | 0.065 | 26.273 | 0.024 |
| | | 15 | -0.009 | 0.018 | 26.279 | 0.035 |
| | | 16 | 0.045 | -0.011 | 26.433 | 0.048 |
| | | 17 | 0.140 | 0.102 | 27.968 | 0.045 |
| | | 18 | 0.113 | 0.041 | 29.001 | 0.048 |
| | | 19 | 0.042 | -0.015 | 29.148 | 0.064 |
| | | 20 | -0.015 | 0.018 | 29.166 | 0.085 |

Based on the outputs above, suggest **THREE (3)** possible ARIMA($p$, $d$, $q$) models with reasons. (6 marks)

(b) Given the estimated ARIMA models as follows:

Dependent Variable: INFLATION
Method: Least Squares
Date: 12/03/15 Time: 09:50
Sample (adjusted): 1967 2014
Included observations: 48 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | 1.845587 | 0.582650 | 3.167572 | 0.0027 |
| INFLATION(-1) | 0.472127 | 0.128788 | 3.665938 | 0.0006 |

| | | | |
|---|---|---|---|
| R-squared | 0.226099 | Mean dependent var | 3.455745 |
| Adjusted R-squared | 0.209275 | S.D. dependent var | 2.982802 |
| S.E. of regression | 2.652389 | Akaike info criterion | 4.829572 |
| Sum squared resid | 323.6177 | Schwarz criterion | 4.907539 |
| Log likelihood | -113.9097 | Hannan-Quinn criter. | 4.859036 |
| F-statistic | 13.43910 | Durbin-Watson stat | 1.799707 |
| Prob(F-statistic) | 0.000637 | | |

**Continued...**

Dependent Variable: D(INFLATION)
Method: Least Squares
Date: 12/02/15 Time: 13:53
Sample (adjusted): 1968 2014
Included observations: 47 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | -0.027270 | 0.446216 | -0.061114 | 0.9515 |
| D(INFLATION(-1)) | -0.132689 | 0.145700 | -0.910700 | 0.3673 |

| | | | |
|---|---|---|---|
| R-squared | 0.018097 | Mean dependent var | -0.030480 |
| Adjusted R-squared | -0.003723 | S.D. dependent var | 3.053326 |
| S.E. of regression | 3.059005 | Akaike info criterion | 5.115678 |
| Sum squared resid | 421.0880 | Schwarz criterion | 5.194407 |
| Log likelihood | -118.2184 | Hannan-Quinn criter. | 5.145304 |
| F-statistic | 0.829375 | Durbin-Watson stat | 1.980824 |
| Prob(F-statistic) | 0.367306 | | |

(i) Based on the EViews output above, specify the ARIMA($p$, $d$, $q$) models for each output. (6 marks)

(ii) Suppose the table below shows the inflation rate data:

| Year | Inflation Rate |
|---|---|
| 2011 | 6.7 |
| 2012 | 7.8 |
| 2013 | 8.6 |
| 2014 | 10.2 |

Based on the data above, forecast the inflation rate using the ARIMA models as in part (i) respectively for year 2013 and 2014. (4 marks)

(iii) Assume the RMSE of the both models are 16.87. Construct a 95% prediction interval for the forecast of inflation rate using each ARIMA model for year 2014. (4 marks)

(c) Explain **TWO (2)** principles used in constructing the forecasts. (5 marks)

**[Total marks: 25 marks]**

**Continued...**

## Question 3

The regression below reports information on homes sold in Cyberjaya area from year 1980 - 2013 (the figures in parentheses are p-values):

$$Y_i = \underset{(0.1356)}{92946.246} + \underset{(0.0951)}{1519.124X_{1i}} + \underset{(0.0269)}{51.591X_{2i}} + \underset{(0.1978)}{955.298X_{3i}}$$

$R$-squared = 0.724 $RSS$ = 39.842 F-statistics = 369.45 (0.0001)

where $Y_i$ = selling price of homes (in RM)
$X_{1i}$ = number of bedrooms
$X_{2i}$ = size of the home (in square feet)
$X_{3i}$ = distance from the center of city (in kilometer)

Based on the information above, answer the following questions:

(a) Perform $t$-test for each independent variable and discuss its significance in explaining the selling price of homes at 5% significance level. (9 marks)

(b) Perform $F$-test to test the overall model at 1% significance level. (5 marks)

(c) Interpret the value of the coefficient of determination. (2 marks)

(d) Given that $X_1 = 3$, $X_2 = 896.55$, and $X_3 = 31.5$ in 2014, forecast the selling price of homes in 2014. (3 marks)

(e) Based on the forecasted price of homes in part (d), create a 95% prediction interval for 2014. Assume that the estimated standard error is 5.96. (4 marks)

(f) Would you be surpriced if the actual price of home in 2014 is RM100,549? Explain. (2 marks)

**[Total marks: 25 marks]**

## Question 4

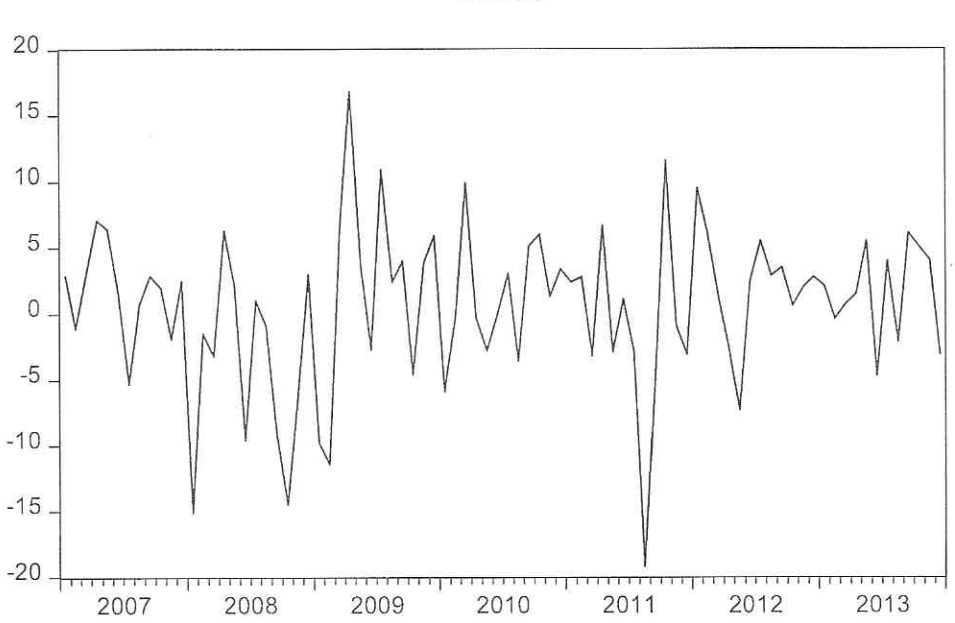
The stock market is one of the most important ways for companies to raise money through public trading. The liquidity that an exchange affords the investors enables their holders to quickly and easily sell securities. History has shown that the price of stocks and other assets is an important part of the dynamics of economic activity, and can influence or be an indicator of social mood. An economy where the stock market is on the rise is considered to be an up-and-coming economy. In fact, the stock market is often considered the primary indicator of the strength and development of a country's economic growth.

**Continued...**

Rising share prices tend to be associated with increased business investment and vice versa. Share prices also affect the wealth of households and their consumption. Therefore, the central bank tends to keep an eye on the behaviour of the stock market.

(a) Based on the statement above, use PHIVE as a guide to your stock prices forecast in the stock market. (*Assume the data that you need are available.*) (15 marks)

(b) Below is the time line for stock prices of DAX30 from January 2007 to December 2013:




Does the DAX30 exhibit any seasonal factor? Explain. (3 marks)

(c) Consider the following EViews outputs of unit root test and correlogram for DAX30:

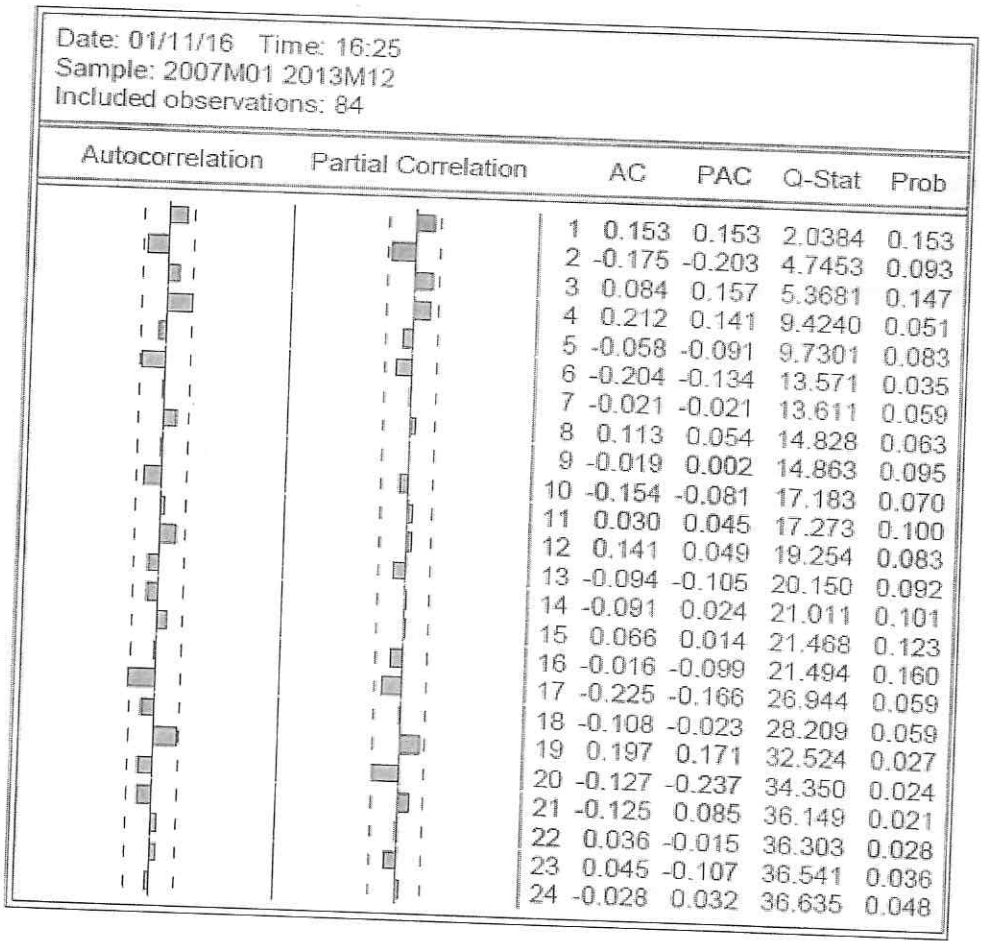
Null Hypothesis: DAX30 has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=11)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -7.696828 | 0.0000 |
| Test critical values: | 1% level | -3.511262 | |
| | 5% level | -2.896779 | |
| | 10% level | -2.585626 | |

*MacKinnon (1996) one-sided p-values.

**Continued...**

Correlogram of DAX30



Date: 01/11/16 Time: 16:25
Sample: 2007M01 2013M12
Included observations: 84

| Autocorrelation | Partial Correlation | | AC | PAC | Q-Stat | Prob |
|---|---|---|---|---|---|---|
| | | 1 | 0.153 | 0.153 | 2.0384 | 0.153 |
| | | 2 | -0.175 | -0.203 | 4.7453 | 0.093 |
| | | 3 | 0.084 | 0.157 | 5.3681 | 0.147 |
| | | 4 | 0.212 | 0.141 | 9.4240 | 0.051 |
| | | 5 | -0.058 | -0.091 | 9.7301 | 0.083 |
| | | 6 | -0.204 | -0.134 | 13.571 | 0.035 |
| | | 7 | -0.021 | -0.021 | 13.611 | 0.059 |
| | | 8 | 0.113 | 0.054 | 14.828 | 0.063 |
| | | 9 | -0.019 | 0.002 | 14.863 | 0.095 |
| | | 10 | -0.154 | -0.081 | 17.183 | 0.070 |
| | | 11 | 0.030 | 0.045 | 17.273 | 0.100 |
| | | 12 | 0.141 | 0.049 | 19.254 | 0.083 |
| | | 13 | -0.094 | -0.105 | 20.150 | 0.092 |
| | | 14 | -0.091 | 0.024 | 21.011 | 0.101 |
| | | 15 | 0.066 | 0.014 | 21.468 | 0.123 |
| | | 16 | -0.016 | -0.099 | 21.494 | 0.160 |
| | | 17 | -0.225 | -0.166 | 26.944 | 0.059 |
| | | 18 | -0.108 | -0.023 | 28.209 | 0.059 |
| | | 19 | 0.197 | 0.171 | 32.524 | 0.027 |
| | | 20 | -0.127 | -0.237 | 34.350 | 0.024 |
| | | 21 | -0.125 | 0.085 | 36.149 | 0.021 |
| | | 22 | 0.036 | -0.015 | 36.303 | 0.028 |
| | | 23 | 0.045 | -0.107 | 36.541 | 0.036 |
| | | 24 | -0.028 | 0.032 | 36.635 | 0.048 |

Suggest **THREE (3)** suitable forecast models for stock prices of DAX30 in part (b). Explain.

(7 marks)

**[Total marks: 25 marks]**

**End of Paper**

**Formula sheet**

Mean Absolute Deviation (MAD) $= \dfrac{\sum |d_i|}{n}$

Variance ($S^2$) $= \dfrac{\sum d_i^2}{(n-1)}$

Standard Deviation (S) $= \sqrt{S^2}$

Mean Absolute Error (MAE) $= \dfrac{1}{n}\sum_{i=1}^{n} |Y_{t+i} - F_{t+i}|$

Mean Square Error (MSE) $= \dfrac{1}{n}\sum_{i=1}^{n} (Y_{t+i} - F_{t+i})^2$

Root Mean Square Error (RMSE) $= \sqrt{MSE}$

Simple exponential smoothing (SES)

$F_{t+1} = F_t + \alpha(Y_t - F_t)$

Starting value: $F_{t+1} = Y_t$

Linear exponential smoothing (LES)

$F_t = L_t + T_t$

(a) Starting values at period 1

$L_t = \dfrac{Y_{t-2} + Y_{t-1} + Y_t}{3} + \dfrac{Y_t - Y_{t-2}}{2}$

$T_t = \dfrac{Y_t - Y_{t-2}}{2}$

(b) Values at period 2 onwards

$L_t = L_{t-1} + T_{t-1} + \alpha e_t$

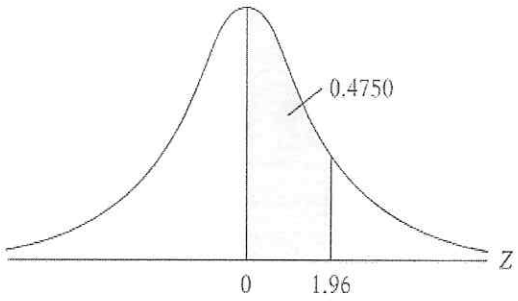
$T_t = T_{t-1} + \alpha\beta e_t$

TABLE D.1
Areas Under the Standardized Normal Distribution

Example

$\Pr(0 \leq Z \leq 1.96) = 0.4750$

$\Pr(Z \geq 1.96) = 0.5 - 0.4750 = 0.025$




| Z | .00 | .01 | .02 | .03 | .04 | .05 | .06 | .07 | .08 | .09 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 | .0000 | .0040 | .0080 | .0120 | .0160 | .0199 | .0239 | .0279 | .0319 | .0359 |
| 0.1 | .0398 | .0438 | .0478 | .0517 | .0557 | .0596 | .0636 | .0675 | .0714 | .0753 |
| 0.2 | .0793 | .0832 | .0871 | .0910 | .0948 | .0987 | .1026 | .1064 | .1103 | .1141 |
| 0.3 | .1179 | .1217 | .1255 | .1293 | .1331 | .1368 | .1406 | .1443 | .1480 | .1517 |
| 0.4 | .1554 | .1591 | .1628 | .1664 | .1700 | .1736 | .1772 | .1808 | .1844 | .1879 |
| 0.5 | .1915 | .1950 | .1985 | .2019 | .2054 | .2088 | .2123 | .2157 | .2190 | .2224 |
| 0.6 | .2257 | .2291 | .2324 | .2357 | .2389 | .2422 | .2454 | .2486 | .2517 | .2549 |
| 0.7 | .2580 | .2611 | .2642 | .2673 | .2704 | .2734 | .2764 | .2794 | .2823 | .2852 |
| 0.8 | .2881 | .2910 | .2939 | .2967 | .2995 | .3023 | .3051 | .3078 | .3106 | .3133 |
| 0.9 | .3159 | .3186 | .3212 | .3238 | .3264 | .3289 | .3315 | .3340 | .3365 | .3389 |
| 1.0 | .3413 | .3438 | .3461 | .3485 | .3508 | .3531 | .3554 | .3577 | .3599 | .3621 |
| 1.1 | .3643 | .3665 | .3686 | .3708 | .3729 | .3749 | .3770 | .3790 | .3810 | .3830 |
| 1.2 | .3849 | .3869 | .3888 | .3907 | .3925 | .3944 | .3962 | .3980 | .3997 | .4015 |
| 1.3 | .4032 | .4049 | .4066 | .4082 | .4099 | .4115 | .4131 | .4147 | .4162 | .4177 |
| 1.4 | .4192 | .4207 | .4222 | .4236 | .4251 | .4265 | .4279 | .4292 | .4306 | .4319 |
| 1.5 | .4332 | .4345 | .4357 | .4370 | .4382 | .4394 | .4406 | .4418 | .4429 | .4441 |
| 1.6 | .4452 | .4463 | .4474 | .4484 | .4495 | .4505 | .4515 | .4525 | .4535 | .4545 |
| 1.7 | .4454 | .4564 | .4573 | .4582 | .4591 | .4599 | .4608 | .4616 | .4625 | .4633 |
| 1.8 | .4641 | .4649 | .4656 | .4664 | .4671 | .4678 | .4686 | .4693 | .4699 | .4706 |
| 1.9 | .4713 | .4719 | .4726 | .4732 | .4738 | .4744 | .4750 | .4756 | .4761 | .4767 |
| 2.0 | .4772 | .4778 | .4783 | .4788 | .4793 | .4798 | .4803 | .4808 | .4812 | .4817 |
| 2.1 | .4821 | .4826 | .4830 | .4834 | .4838 | .4842 | .4846 | .4850 | .4854 | .4857 |
| 2.2 | .4861 | .4864 | .4868 | .4871 | .4875 | .4878 | .4881 | .4884 | .4887 | .4890 |
| 2.3 | .4893 | .4896 | .4898 | .4901 | .4904 | .4906 | .4909 | .4911 | .4913 | .4916 |
| 2.4 | .4918 | .4920 | .4922 | .4925 | .4927 | .4929 | .4931 | .4932 | .4934 | .4936 |
| 2.5 | .4938 | .4940 | .4941 | .4943 | .4945 | .4946 | .4948 | .4949 | .4951 | .4952 |
| 2.6 | .4953 | .4955 | .4956 | .4957 | .4959 | .4960 | .4961 | .4962 | .4963 | .4964 |
| 2.7 | .4965 | .4966 | .4967 | .4968 | .4969 | .4970 | .4971 | .4972 | .4973 | .4974 |
| 2.8 | .4974 | .4975 | .4976 | .4977 | .4977 | .4978 | .4979 | .4979 | .4980 | .4981 |
| 2.9 | .4981 | .4982 | .4982 | .4983 | .4984 | .4984 | .4985 | .4985 | .4986 | .4986 |
| 3.0 | .4987 | .4987 | .4987 | .4988 | .4988 | .4989 | .4989 | .4989 | .4990 | .4990 |

*Note:* This table gives the area in the right-hand tail of the distribution (i.e., $Z \geq 0$). But since the normal distribution is symmetrical about $Z = 0$, the area in the left-hand tail is the same as the area in the corresponding right-hand tail. For example, $P(-1.96 \leq Z \leq 0) = 0.4750$. Therefore, $P(-1.96 \leq Z \leq 1.96) = 2(0.4750) = 0.95$.

## TABLE D.2
### Percentage Points of the $t$ Distribution

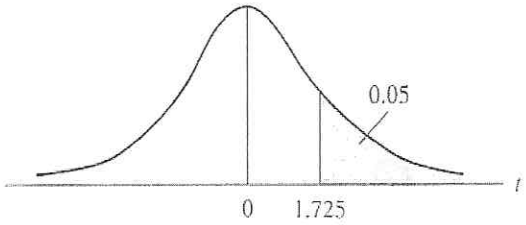
Source: From E. S. Pearson and H. O. Hartley, eds., *Biometrika Tables for Statisticians*, vol. 1, 3d ed., table 12, Cambridge University Press, New York, 1966. Reproduced by permission of the editors and trustees of *Biometrika*.

Example

$\Pr(t > 2.086) = 0.025$

$\Pr(t > 1.725) = 0.05$ for df = 20

$\Pr(|t| > 1.725) = 0.10$




| Pr / df | 0.25<br>0.50 | 0.10<br>0.20 | 0.05<br>0.10 | 0.025<br>0.05 | 0.01<br>0.02 | 0.005<br>0.010 | 0.001<br>0.002 |
|---|---|---|---|---|---|---|---|
| 1 | 1.000 | 3.078 | 6.314 | 12.706 | 31.821 | 63.657 | 318.31 |
| 2 | 0.816 | 1.886 | 2.920 | 4.303 | 6.965 | 9.925 | 22.327 |
| 3 | 0.765 | 1.638 | 2.353 | 3.182 | 4.541 | 5.841 | 10.214 |
| 4 | 0.741 | 1.533 | 2.132 | 2.776 | 3.747 | 4.604 | 7.173 |
| 5 | 0.727 | 1.476 | 2.015 | 2.571 | 3.365 | 4.032 | 5.893 |
| 6 | 0.718 | 1.440 | 1.943 | 2.447 | 3.143 | 3.707 | 5.208 |
| 7 | 0.711 | 1.415 | 1.895 | 2.365 | 2.998 | 3.499 | 4.785 |
| 8 | 0.706 | 1.397 | 1.860 | 2.306 | 2.896 | 3.355 | 4.501 |
| 9 | 0.703 | 1.383 | 1.833 | 2.262 | 2.821 | 3.250 | 4.297 |
| 10 | 0.700 | 1.372 | 1.812 | 2.228 | 2.764 | 3.169 | 4.144 |
| 11 | 0.697 | 1.363 | 1.796 | 2.201 | 2.718 | 3.106 | 4.025 |
| 12 | 0.695 | 1.356 | 1.782 | 2.179 | 2.681 | 3.055 | 3.930 |
| 13 | 0.694 | 1.350 | 1.771 | 2.160 | 2.650 | 3.012 | 3.852 |
| 14 | 0.692 | 1.345 | 1.761 | 2.145 | 2.624 | 2.977 | 3.787 |
| 15 | 0.691 | 1.341 | 1.753 | 2.131 | 2.602 | 2.947 | 3.733 |
| 16 | 0.690 | 1.337 | 1.746 | 2.120 | 2.583 | 2.921 | 3.686 |
| 17 | 0.689 | 1.333 | 1.740 | 2.110 | 2.567 | 2.898 | 3.646 |
| 18 | 0.688 | 1.330 | 1.734 | 2.101 | 2.552 | 2.878 | 3.610 |
| 19 | 0.688 | 1.328 | 1.729 | 2.093 | 2.539 | 2.861 | 3.579 |
| 20 | 0.687 | 1.325 | 1.725 | 2.086 | 2.528 | 2.845 | 3.552 |
| 21 | 0.686 | 1.323 | 1.721 | 2.080 | 2.518 | 2.831 | 3.527 |
| 22 | 0.686 | 1.321 | 1.717 | 2.074 | 2.508 | 2.819 | 3.505 |
| 23 | 0.685 | 1.319 | 1.714 | 2.069 | 2.500 | 2.807 | 3.485 |
| 24 | 0.685 | 1.318 | 1.711 | 2.064 | 2.492 | 2.797 | 3.467 |
| 25 | 0.684 | 1.316 | 1.708 | 2.060 | 2.485 | 2.787 | 3.450 |
| 26 | 0.684 | 1.315 | 1.706 | 2.056 | 2.479 | 2.779 | 3.435 |
| 27 | 0.684 | 1.314 | 1.703 | 2.052 | 2.473 | 2.771 | 3.421 |
| 28 | 0.683 | 1.313 | 1.701 | 2.048 | 2.467 | 2.763 | 3.408 |
| 29 | 0.683 | 1.311 | 1.699 | 2.045 | 2.462 | 2.756 | 3.396 |
| 30 | 0.683 | 1.310 | 1.697 | 2.042 | 2.457 | 2.750 | 3.385 |
| 40 | 0.681 | 1.303 | 1.684 | 2.021 | 2.423 | 2.704 | 3.307 |
| 60 | 0.679 | 1.296 | 1.671 | 2.000 | 2.390 | 2.660 | 3.232 |
| 120 | 0.677 | 1.289 | 1.658 | 1.980 | 2.358 | 2.617 | 3.160 |
| $\infty$ | 0.674 | 1.282 | 1.645 | 1.960 | 2.326 | 2.576 | 3.090 |

*Note:* The smaller probability shown at the head of each column is the area in one tail; the larger probability is the area in both tails.